

## SYSTEM AND METHOD FOR AUTOMATIC RIGHT-LEFT EAR DETECTION FOR HEADPHONES

### FIELD

[0001] Embodiments of the invention relate generally to a system and method for automatic right-left ear detection for headphones. Specifically, in one embodiment, the headphone includes two earcups that are identical and include at least three microphones to capture acoustic signals. In another embodiment, each of the earcups may be coupled to an earcup detector that receives the microphone signals from at least one of the earcups and determines which of the earcups is worn on the user's right ear.

### BACKGROUND

[0002] Currently, headphones include a pair of earcups (or earbuds) that are marked as left and right, respectively. The right and left earcups are manufactured to include components specific to the right and left earcups, respectively, in order to allow the earcups to play audio corresponding to the right and the left stereo channels, respectively. Accordingly, the signals that are sent and received from each earcup are specific to the earcup being the right or the left earcup.

[0003] Further, a number of consumer electronic devices are adapted to receive speech via microphone ports or headphones. While the typical example is a portable telecommunications device (mobile telephone), with the advent of Voice over IP (VoIP), desktop computers, laptop computers and tablet computers may also be used to perform voice communications.

[0004] When using these electronic devices, the user also has the option of using the speakerphone mode or the headphone to receive his speech. However, a common complaint with these hands-free modes of operation is that the speech captured by the microphone port or the headset includes environmental noise such as wind noise, secondary speakers in the background or other background noises. This environmental noise often renders the user's speech unintelligible and thus, degrades the quality of the voice communication.

### SUMMARY

[0005] Generally, embodiments of the invention relate to a system and method for automatic right-left ear detection for a headphone. It would be economically advantageous to manufacture a single earcup design that may be used as both the left and the right earcup. In addition, the headphones may only need to transmit to the connected device the user's speech from one of the earcups.

[0006] In one embodiment, a system for automatic right-left ear detection for a headphone comprises a first earcup and a second earcup that are identical. Each of the first and second earcups includes five microphones which are also used for purposes other than ear detection: a first microphone, a second microphone, a third microphone that is located inside each earcup facing the user's ear cavity, a fourth microphone located on a perimeter of each earcup in a triangle shape with the first and second microphones (top left, top right, and bottom middle), and a fifth microphone located above and to the left of the second microphone on a perimeter of each earcup when looking at an outside housing of each earcup. In one embodiment, when the first earcup is

worn on a user's right ear the first microphone is at a location farther from a user's mouth and the second microphone is at a location closer to the user's mouth.

[0007] In another embodiment, each of the earcups may be coupled to an earcup detector that receives the microphone signals from at least one of the earcups. The earcup detector performs comparisons of the strength or ratio of strengths of the microphone signals from the at least three microphones with a plurality of thresholds to determine which of the earcups is being worn on the user's right ear. The earcup detector generates a right-left signal which is 1 when the earcup is being worn on the user's right ear and 0 when the earcup is being worn on the user's left ear. In one embodiment, that signal may be sent to a microphone controller to select the microphone signals received from the earcup that is being worn on the user's right ear for beamforming and/or transmitting to the connected device. In addition, the earcup detector also generates a VAD signal that may be used as input in noise suppression or automatic gain control.

[0008] The above summary does not include an exhaustive list of all aspects of the present invention. It is contemplated that the invention includes all systems, apparatuses and methods that can be practiced from all suitable combinations of the various aspects summarized above, as well as those disclosed in the Detailed Description below and particularly pointed out in the claims filed with the application. Such combinations may have particular advantages not specifically recited in the above summary.

### BRIEF DESCRIPTION OF THE DRAWINGS

[0009] The embodiments of the invention are illustrated by way of example and not by way of limitation in the figures of the accompanying drawings in which like references indicate similar elements. It should be noted that references to "an" or "one" embodiment of the invention in this disclosure are not necessarily to the same embodiment, and they mean at least one. In the drawings:

[0010] FIG. 1 illustrates an example of headphones in use according to one embodiment of the invention.

[0011] FIG. 2 illustrates an example of the details of the earcups in a first placement in accordance with one embodiment of the invention.

[0012] FIG. 3 illustrates an example of the details of the earcups in a second placement in accordance with one embodiment of the invention.

[0013] FIG. 4 illustrates an example of the details of the earcup being worn on the user's right ear in accordance with one embodiment of the invention.

[0014] FIG. 5 illustrates a flow diagram of an example method for right-left ear detection for a headphone in accordance with one embodiment of the invention.

[0015] FIG. 6 illustrates a flow diagram of an example method of determining which one of the first earcup or the second earcup is being worn on a user's right ear from FIG. 5 in accordance with one embodiment of the invention.

[0016] FIG. 7 illustrates a block diagram of a system for right-left ear detection for a headphone in accordance with one embodiment of the invention.

[0017] FIG. 8 is a block diagram of exemplary components of a mobile device included in the system in FIG. 7 for right-left ear detection for a headphone in accordance with aspects of the present disclosure.